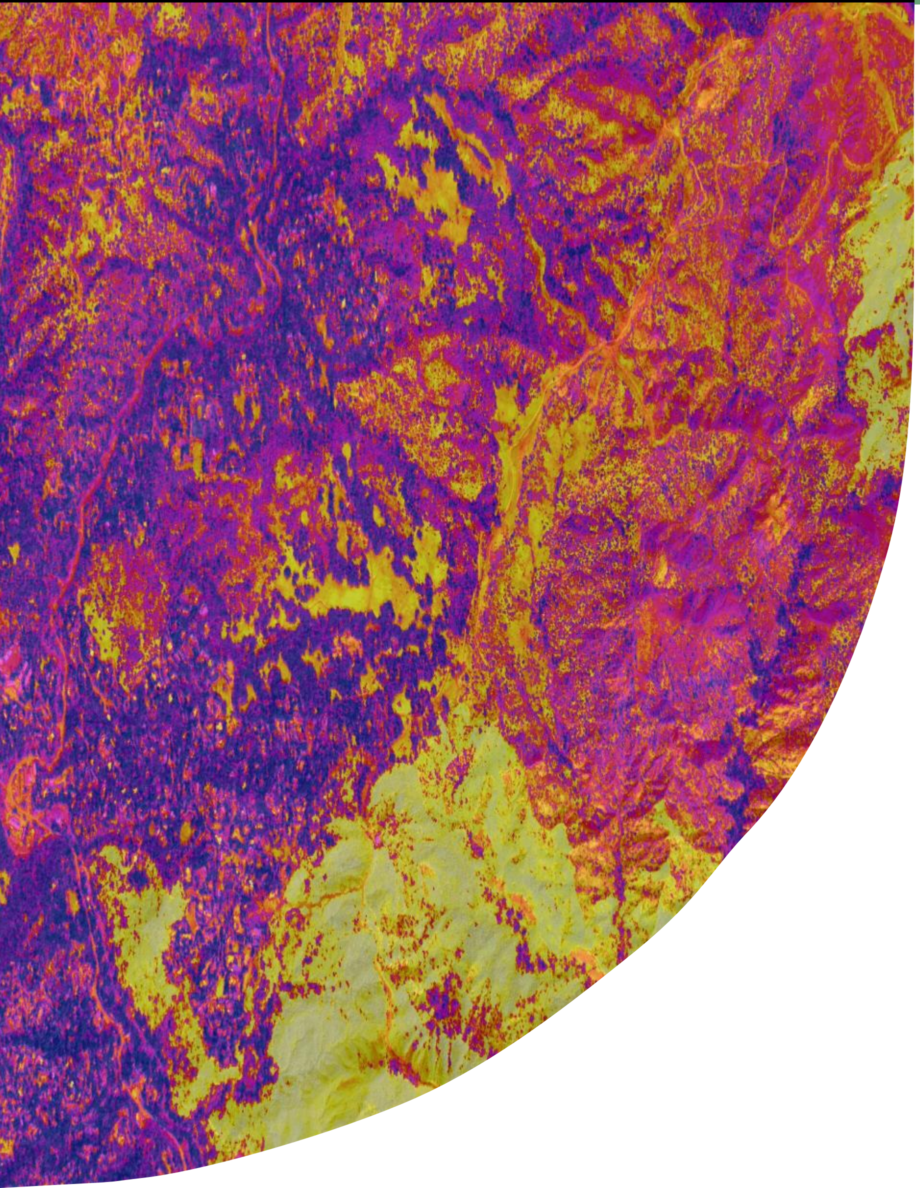
National Aeronautics and
Space Administration



Los Angeles County Ecological Conservation

Mapping and Identifying the Health of Urban Oak Trees in Los Angeles County

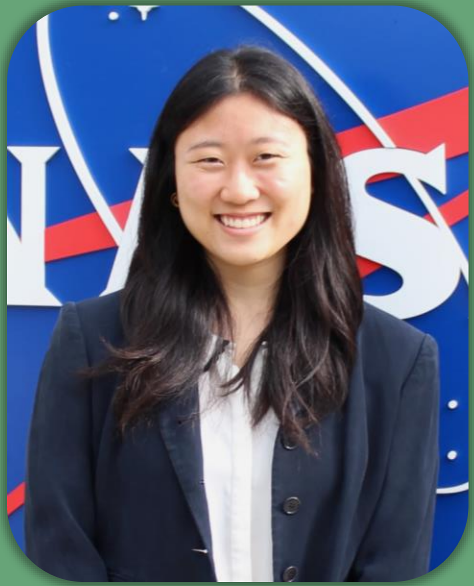
Sofia Ingersoll, Gabrielle Shen, Taylor Simonich,
& Nate Trux (Analytical Mechanics Associates)

California – JPL | Summer 2025

DEVELOP

Meet the Team

Sofia Ingersoll



Gabrielle Shen

Taylor Simonich

Nathan Trux

Image Credit: Sofia Ingersoll

California Oak Woodlands

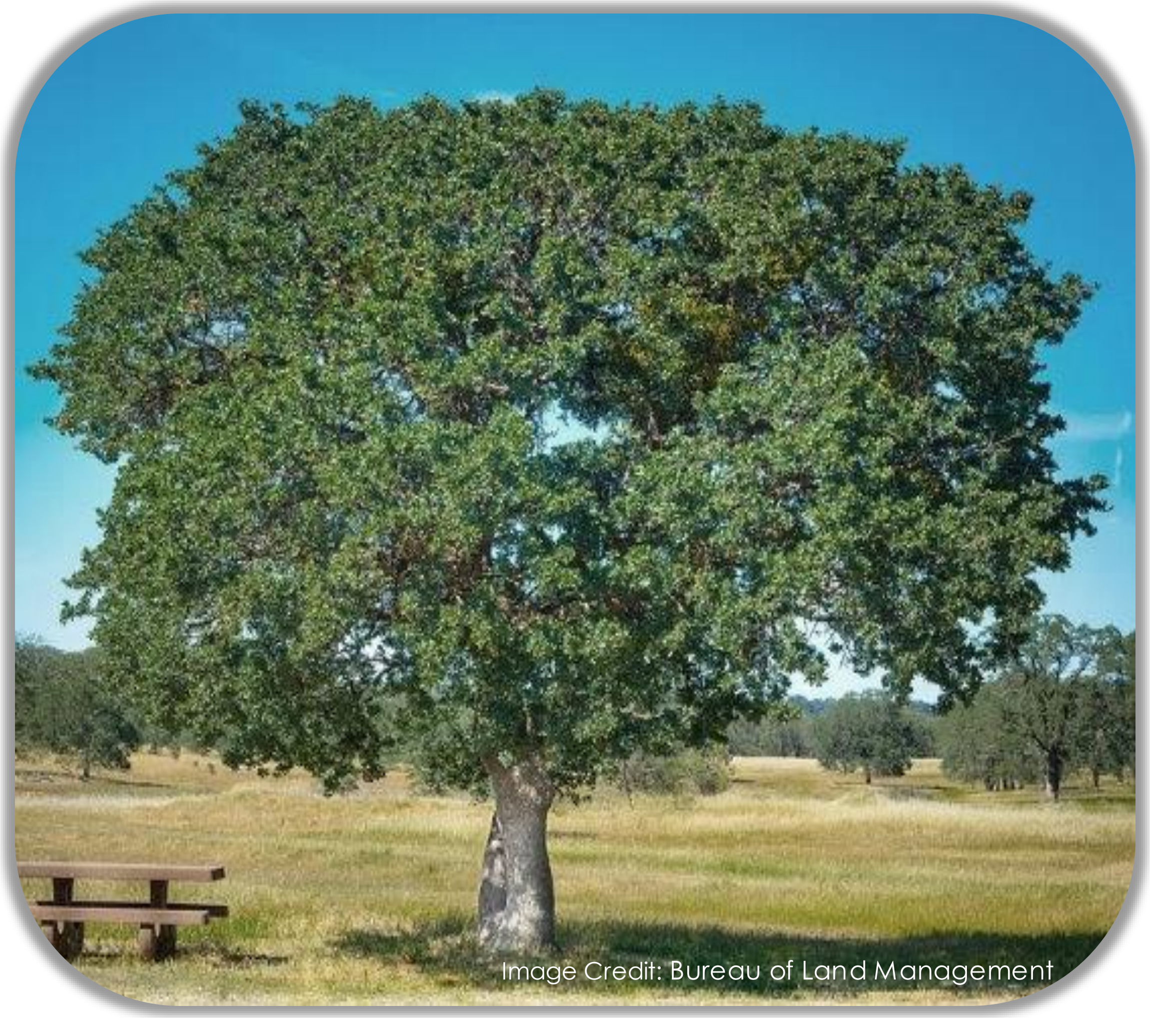


Image Credit: Bureau of Land Management

Image Credit: USDA Pacific Southwest Forest Service

Threats to Oak Trees & Community Concerns

Extreme Weather Events

Goldspotted Oak Borer ("GSOB")

Wildfires

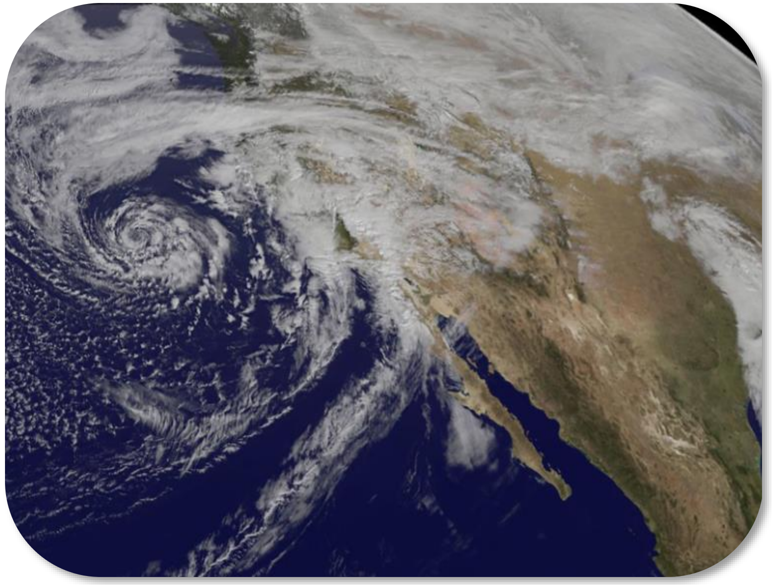


Image Credit: NASA Goddard

Image Credit: USFS Pacific Southwest Region

Image Credit: Grigory Heaton

Our Partners

Los Angeles County Department of Internal Services

Los Angeles County Fire Department

Image Credit: California Historical Society

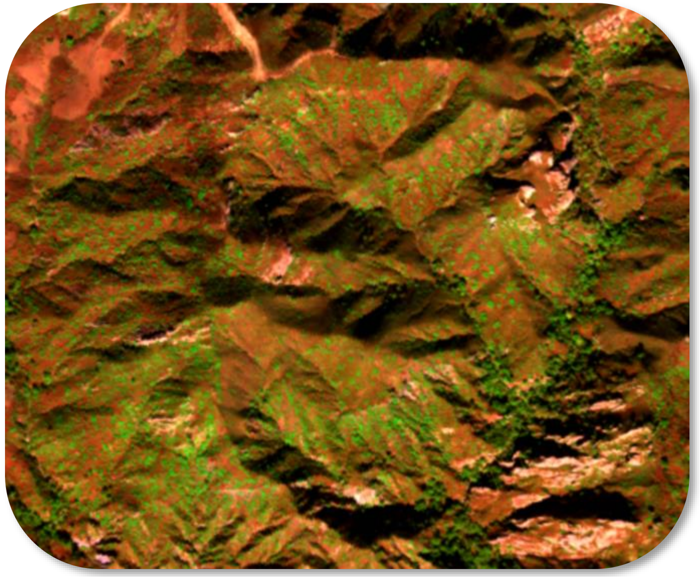
Study Area & Period

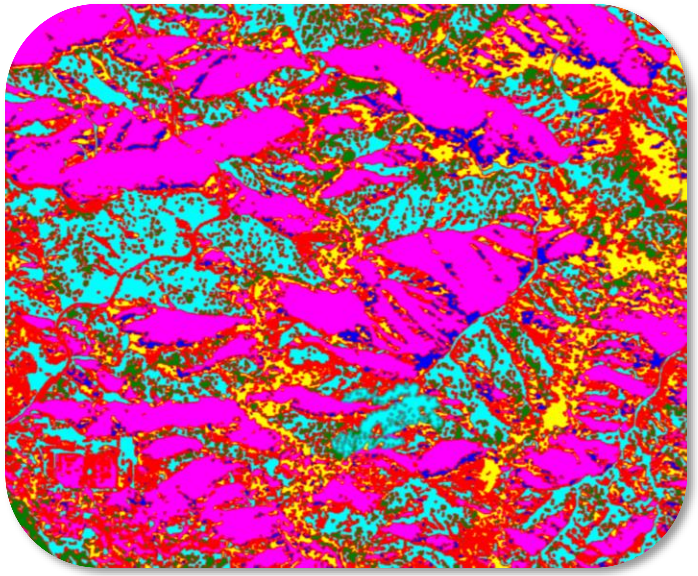
Los Angeles County

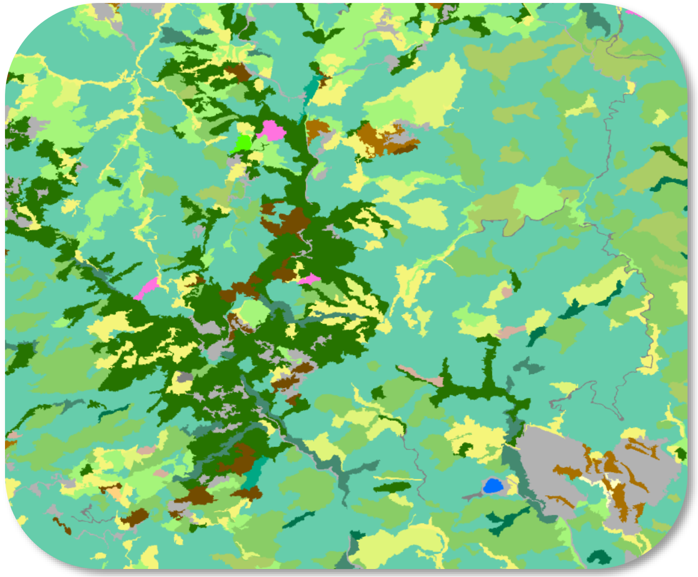
Jan 2015 – July 2025

Basemap: Esri, NASA, CGIAR, USGS, TomTom, Garmin, FAO, NOAA, Esri, © OpenStreetMap contributors

Objectives







Improve granularity, accuracy, and reproducibility of the county's map of oak woodlands

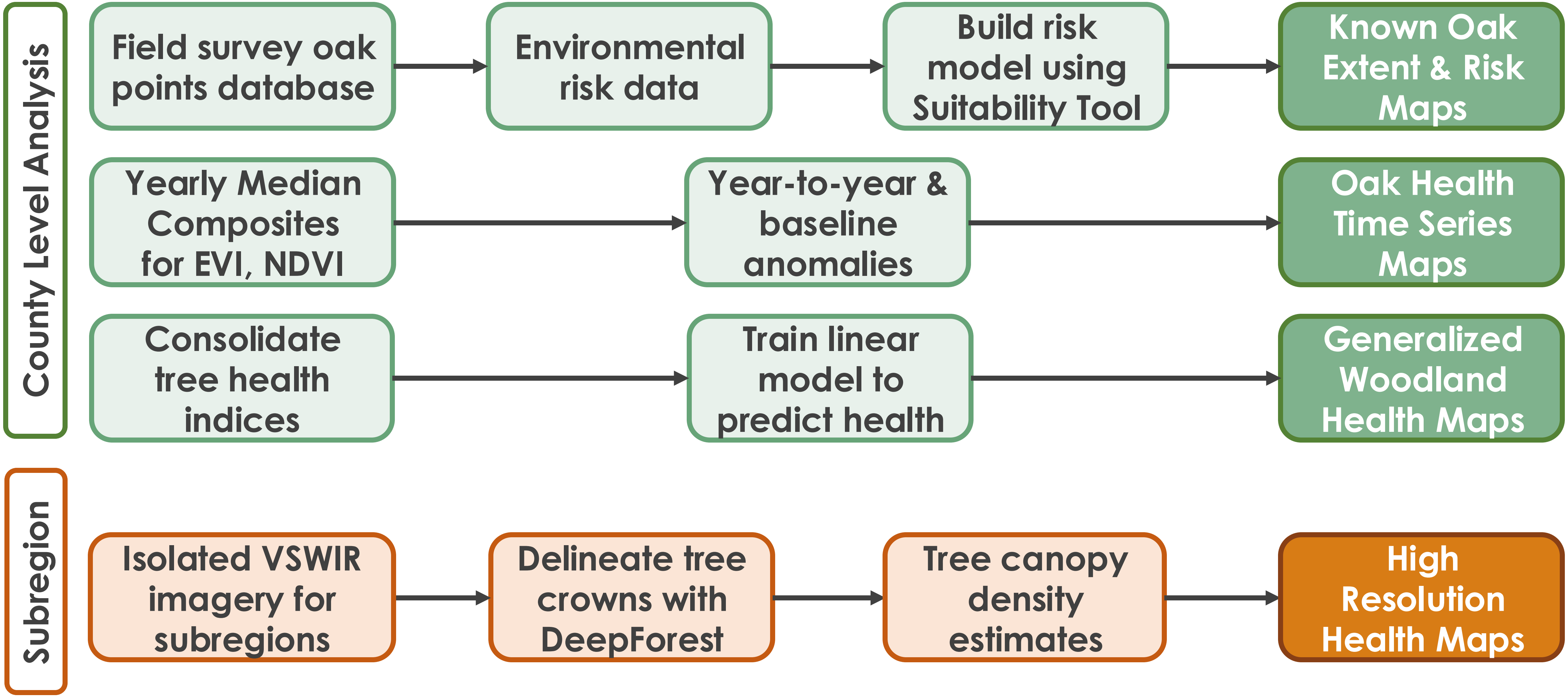
Proactively detect possible GSOB infestations with a health model using remotely sensed health metrics

Assess feasibility of species classification to inform action surrounding forest management

Earth Observations

Image Credits: Scott Kelly, NASA; ESA

Methodology Overview



County Level Analysis

Field survey oak points database → Environmental risk data → Build risk model using Suitability Tool → Known Oak Extent & Risk Maps

Yearly Median Composites for EVI, NDVI → Year-to-year & baseline anomalies → Oak Health Time Series Maps

Consolidate tree health indices → Train linear model to predict health → Generalized Woodland Health Maps

Subregion

Isolated VSWIR imagery for subregions → Delineate tree crowns with DeepForest → Tree canopy density estimates → High Resolution Health Maps

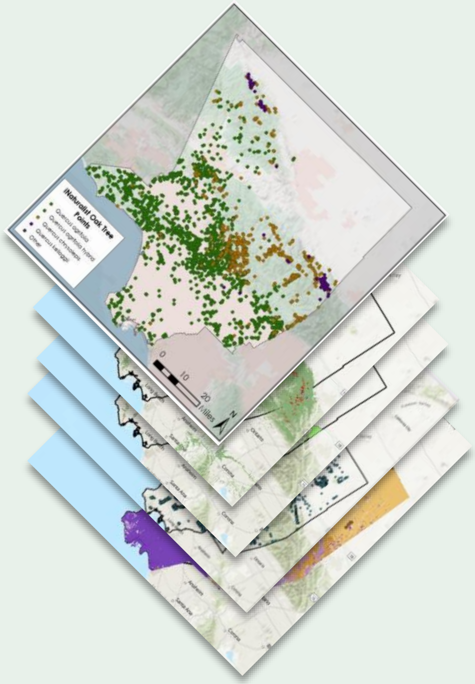
Methodology: Oak Extent, Risk, and Health Maps

Known Oak Points

Topographical Data

Environmental Data

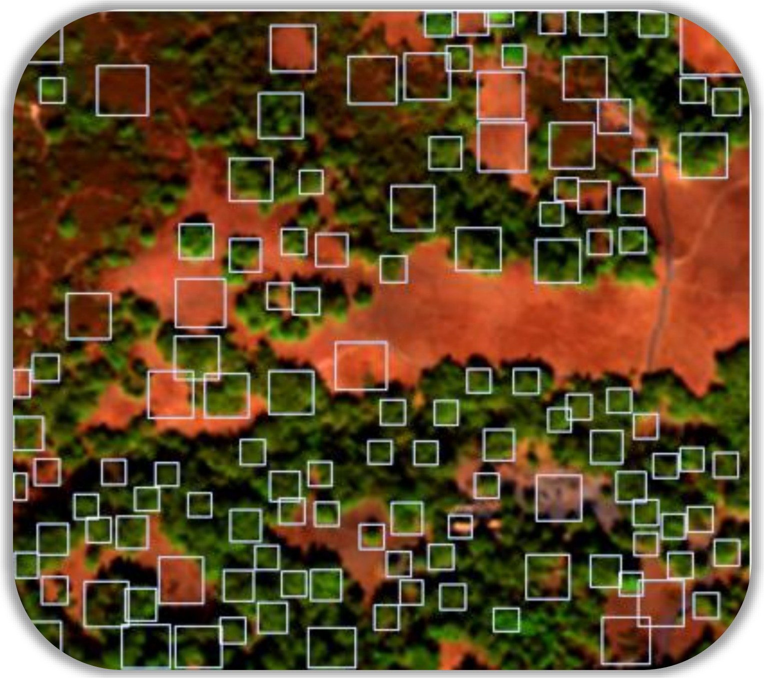
Health Metric Data



Oak Extent, Risk, and Health Maps

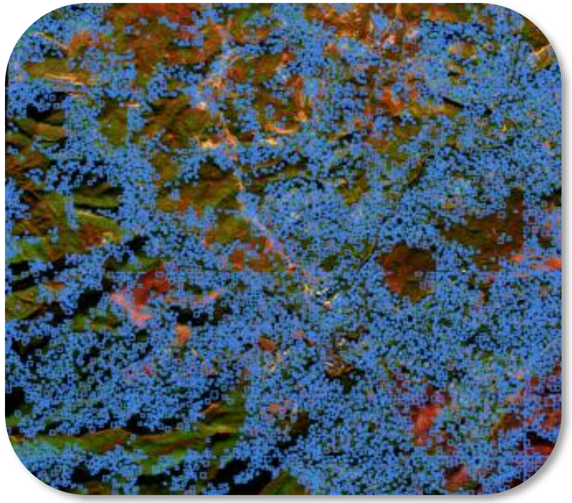
Methodology: Subregion Crown Delineation

The **Python computer vision model** **DeepForest** can **identify individual tree crowns** using high resolution RGB data, derived from **AVIRIS VSWIR**



Data Source & Basemap Imagery: AVIRIS-3

VSWIR Imagery **clipped** to the **tree crown geometry** defined by **DeepForest**



Methodology: Subregion Leaf Area Index (LAI) Map

$$\text{LAI} = \frac{\text{Total Leaf Area}}{\text{Ground Area}}$$

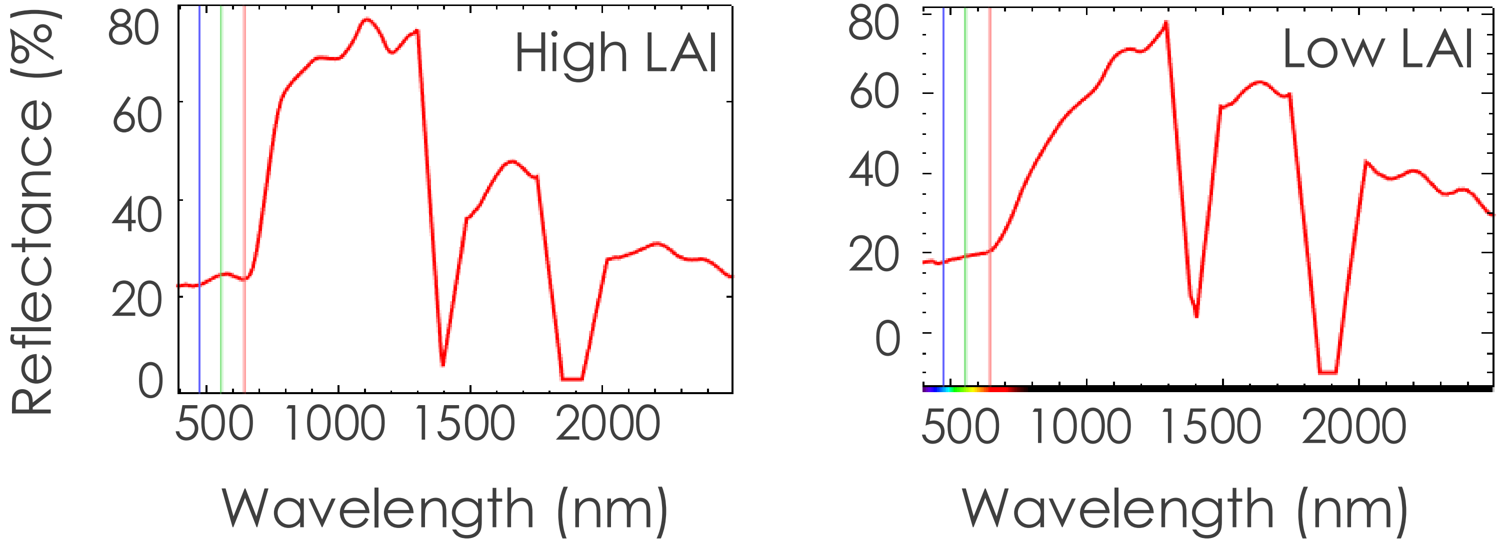
LAI = 1.0

LAI = 0.9

LAI = 0.8

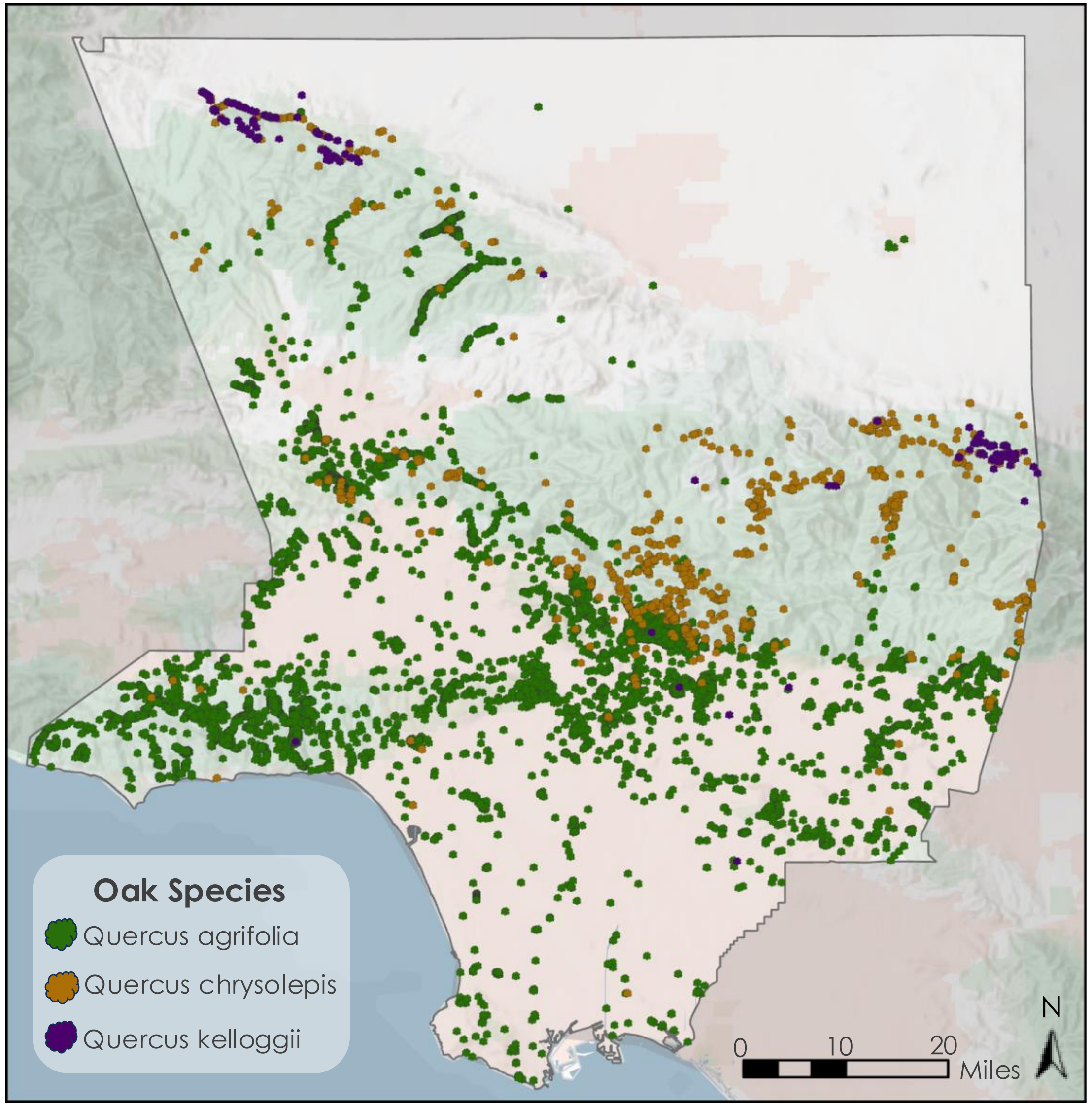
Icon Credit: freesvg.org

Reflectance Signatures of Low and High LAI Canopies



Estimated using differences in reflectance signatures

Known Oak Extent Map



Points from 6 databases

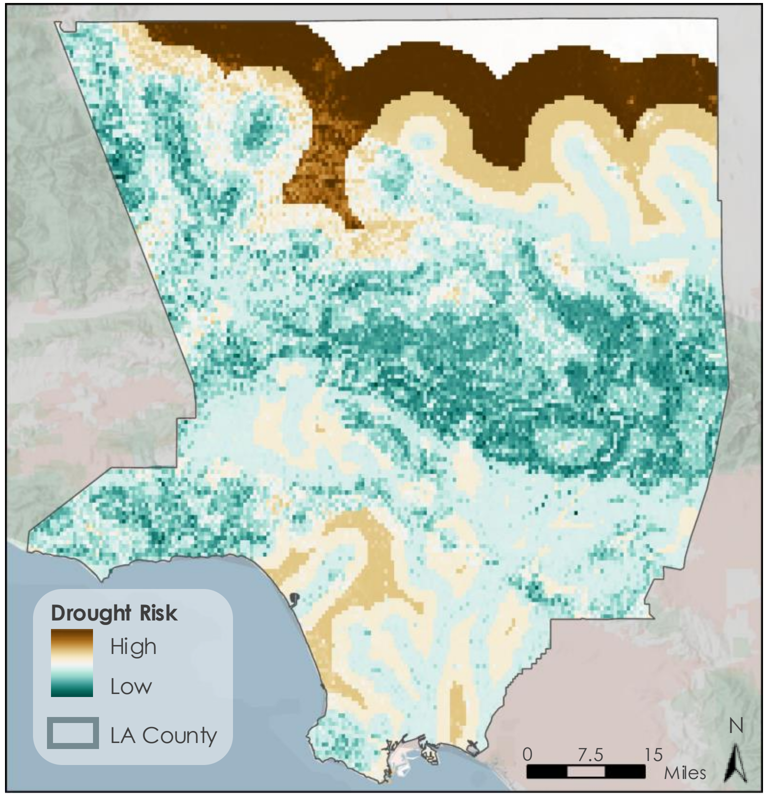
20,000+ individual trees

Displays 3 key species affected by GSOB

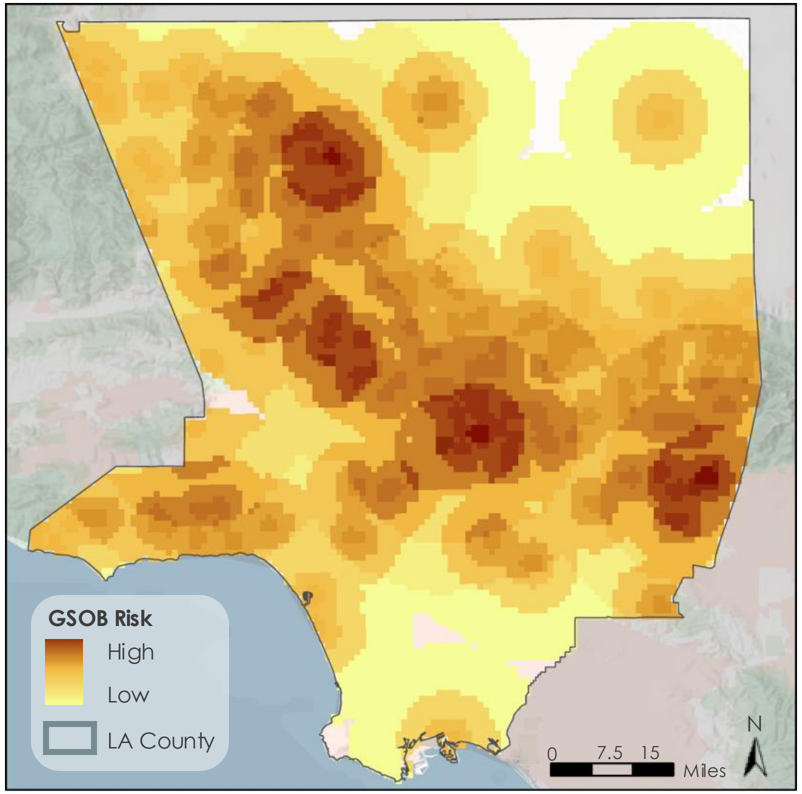
Basemap: Esri, CGIAR, USGS, TomTom, Garmin, FAO, NOAA, Esri, © OpenStreetMap contributors

Oak Woodland Environmental Risk Maps

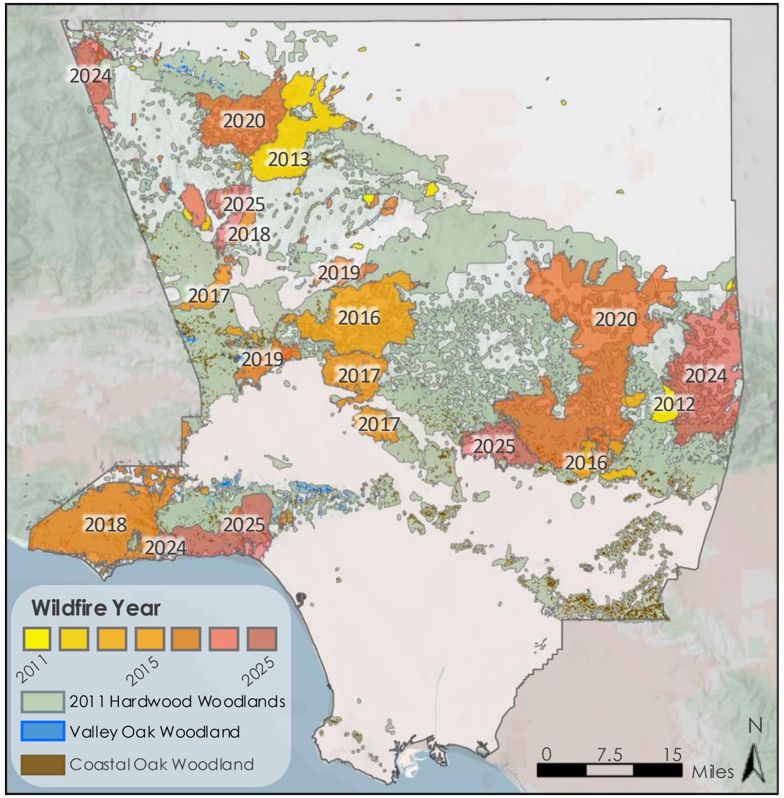
Drought Risk Map



GSOB Risk Map



Wildfire Impact Map

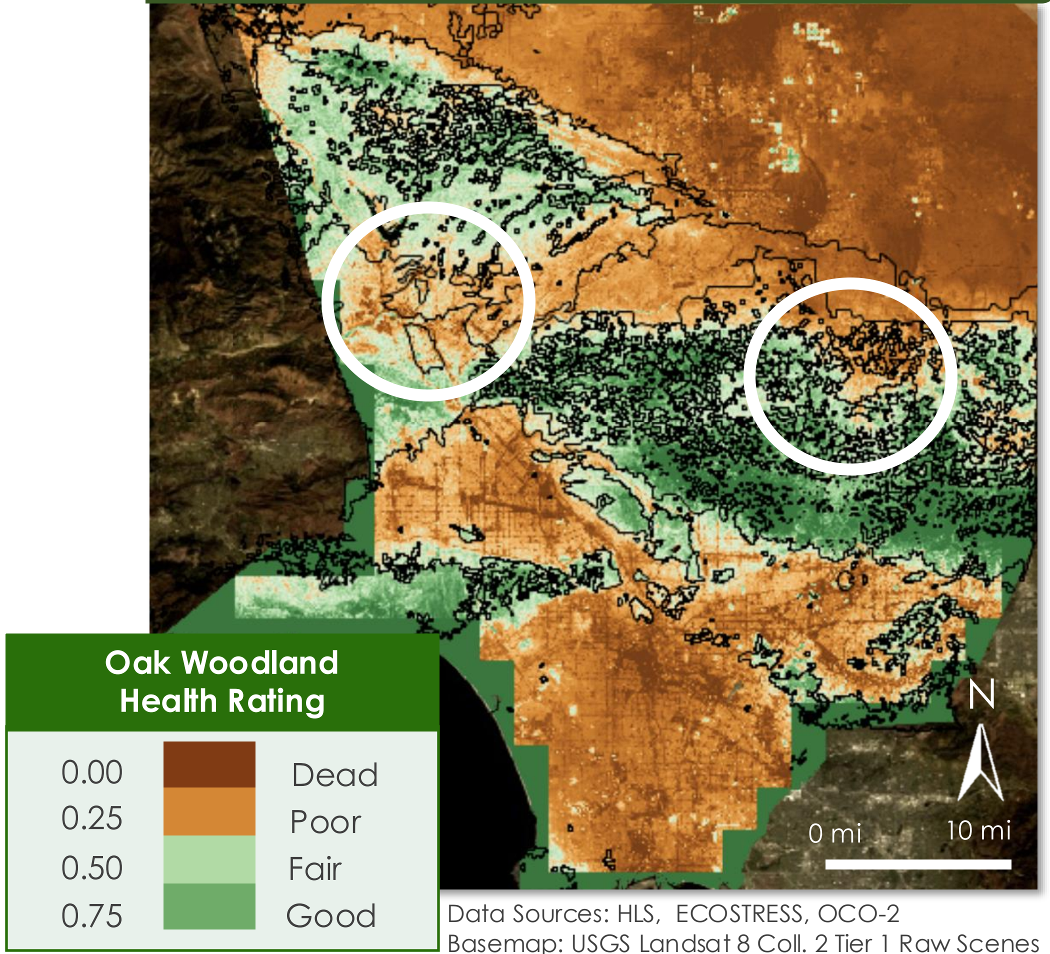


Basemaps: Esri, NASA, CGIAR, USGS, TomTom, Garmin, FAO, NOAA, Esri, © OpenStreetMap contributors

Combined Health Metric Assessment

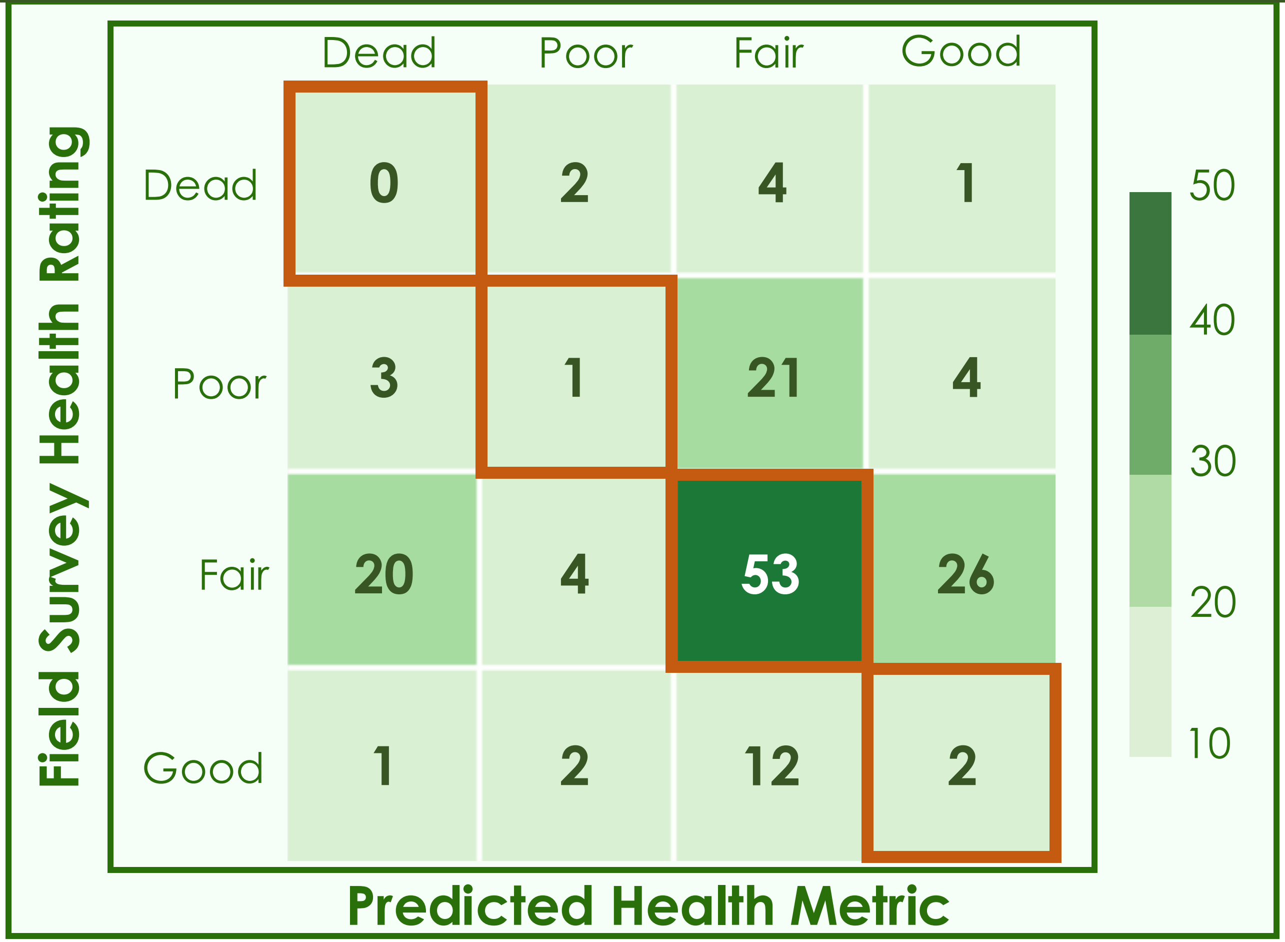
$$\text{Health Metric} = \beta0 + \beta1(\text{NDMI}) + \beta2(\text{NDVI}) + \beta3(\text{EVI}) + \beta4(\text{ESI}) + \beta5(\text{ET}) + \beta6(\text{SIF})$$

2024 Health Predictions



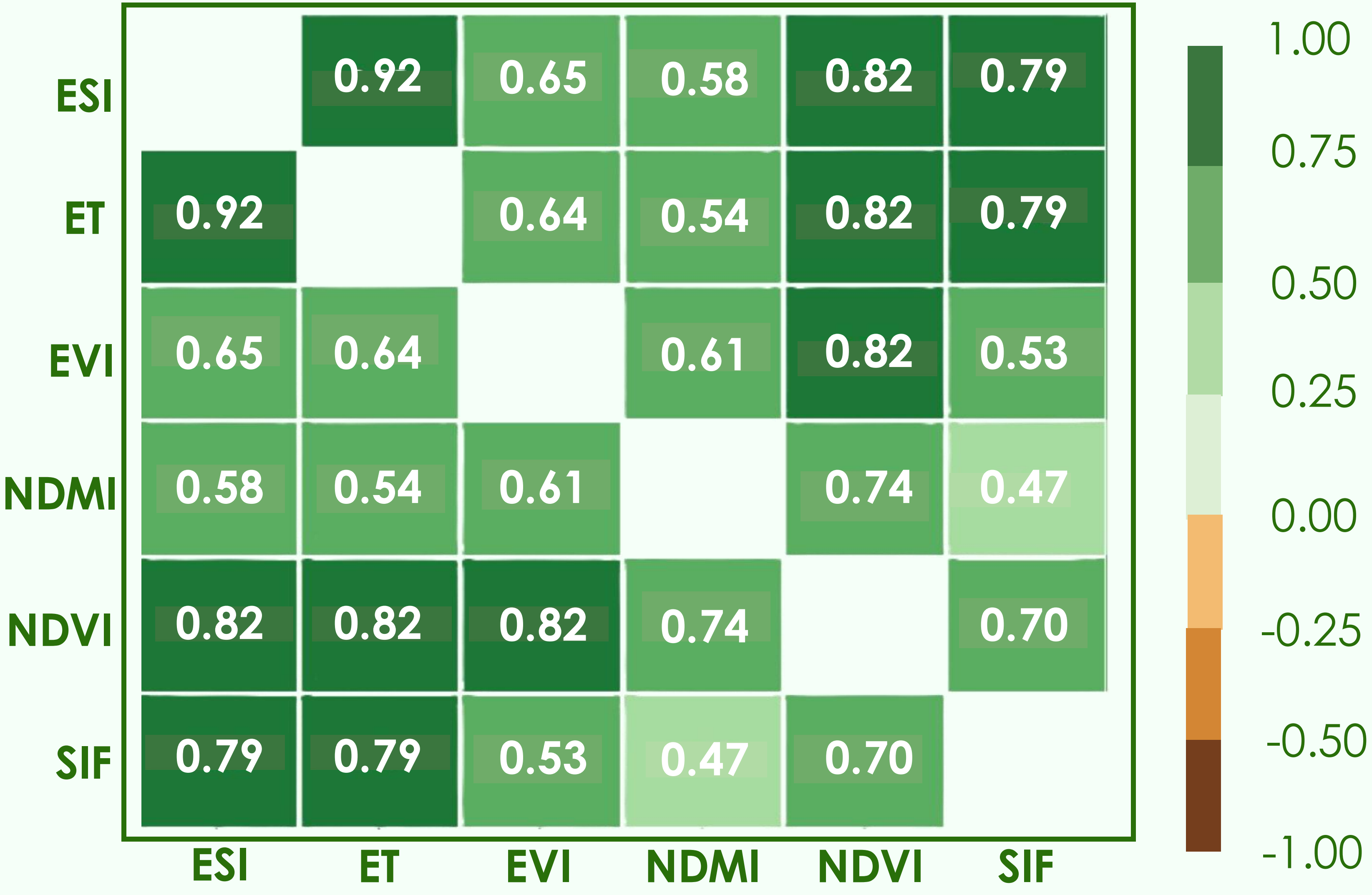
Data Sources: HLS, ECOSTRESS, OCO-2
Basemap: USGS Landsat 8 Coll. 2 Tier 1 Raw Scenes

Predicted vs. Actual Health Matrix



	Dead	Poor	Fair	Good
Dead	0	2	4	1
Poor	3	1	21	4
Fair	20	4	53	26
Good	1	2	12	2

Exploring Health Metric Correlation



	ESI	ET	EVI	NDMI	NDVI	SIF
ESI		0.92	0.65	0.58	0.82	0.79
ET	0.92		0.64	0.54	0.82	0.79
EVI	0.65	0.64		0.61	0.82	0.53
NDMI	0.58	0.54	0.61		0.74	0.47
NDVI	0.82	0.82	0.82	0.74		0.70
SIF	0.79	0.79	0.53	0.47	0.70	

Data Source: (2024) HLS, ECOSTRESS, OCO-2

All health metrics were **positively correlated**

Oak Woodlands Health Annual Changes

Change in Enhanced Vegetation Index

≤ -0.50	🟫	Severe Loss
-0.5 to -0.25	🟧	Strong Loss
-0.25 to 0.00	🟨	Mild Loss
0.00 to 0.25	⬜	Stable
≥ 0.25	🟩	Mild Gain

- Oak Woodland regions exhibited the most change
- Overall, there was little to no gain in vegetation greenness

Data Source: HLS30
Basemap: USGS Landsat 8 Coll. 2 Tier 1 Raw Scenes

Oak Woodlands Health Anomalies Over Time

EVI anomaly from 2015

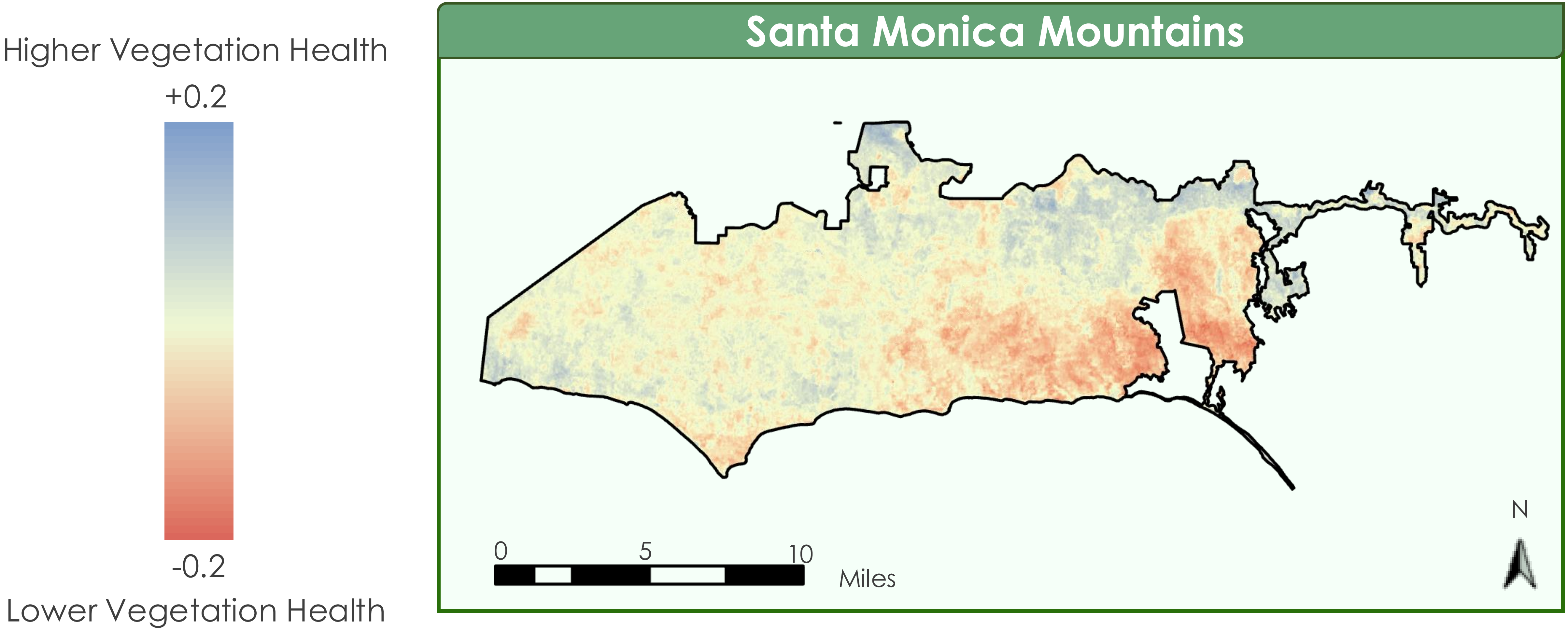
Change in Natural Indices

-0.50	🟫	Severe Loss
-0.25	🟧	Strong Loss
0.00	🟨	Mild Loss
0.25	⬜	Stable
0.50	🟩	Mild Gain

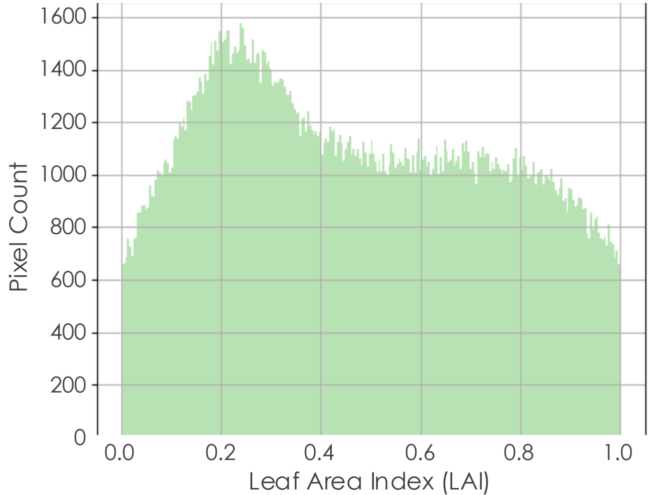
Data Source: HLS30
Basemap: USGS Landsat 8 Coll. 2 Tier 1 Raw Scenes

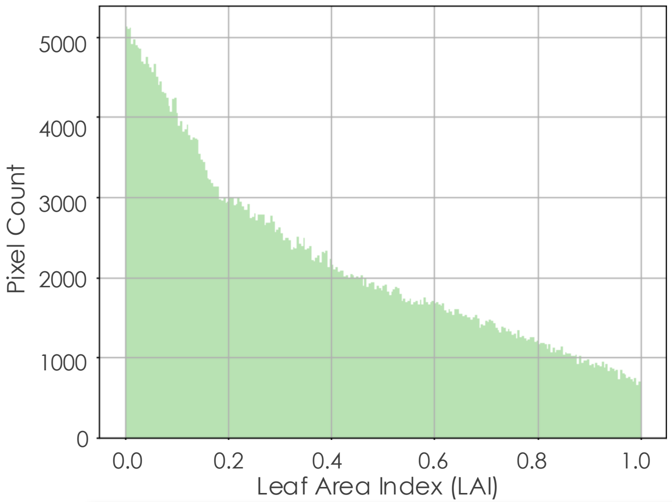
NDVI anomaly from 2015

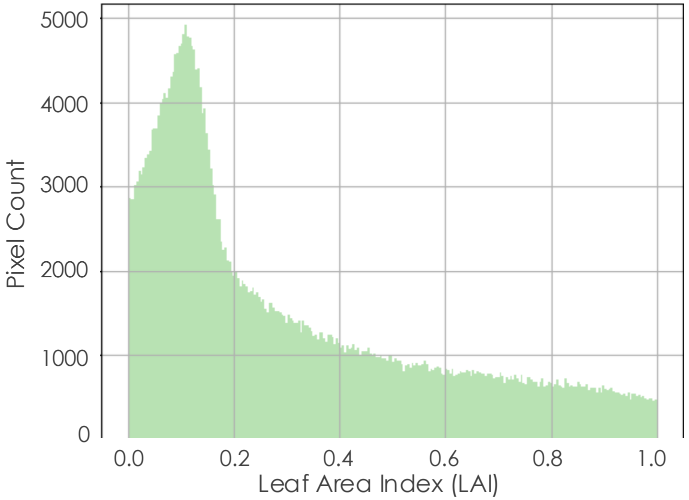
NDVI and ET Rate of Change Over Time (2018–2025)

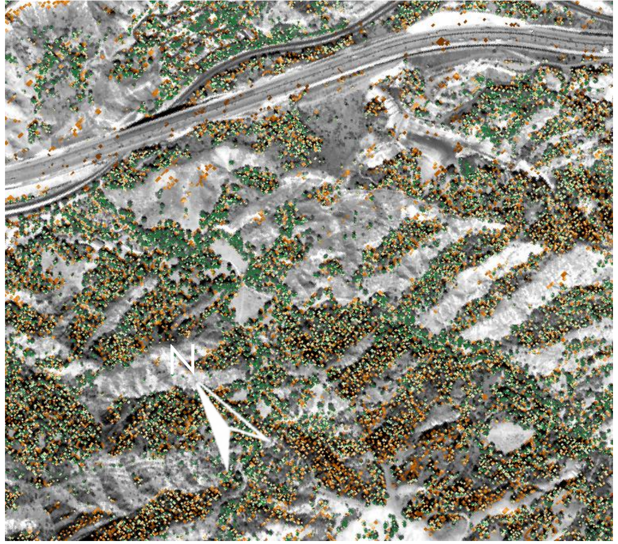


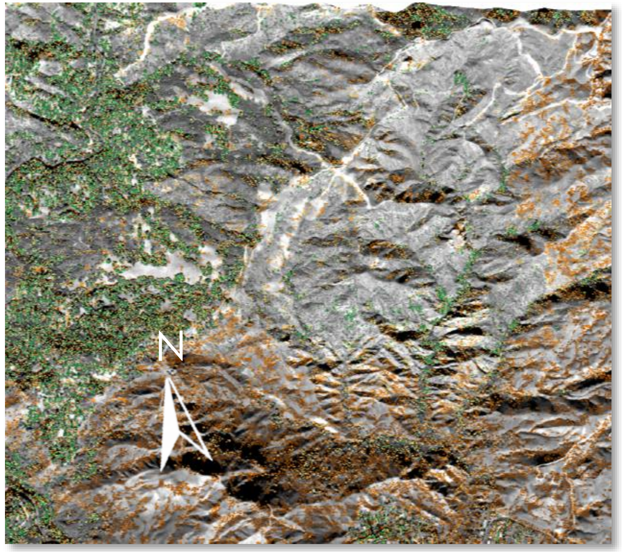
Subregion Leaf Area Index Maps

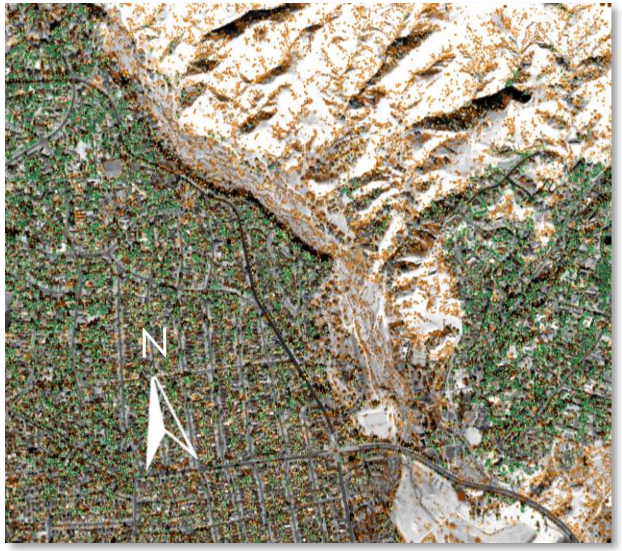

Santa Clarita Tree Canopy LAI


Santa Monica Tree Canopy LAI


Eaton Canyon Tree Canopy LAI

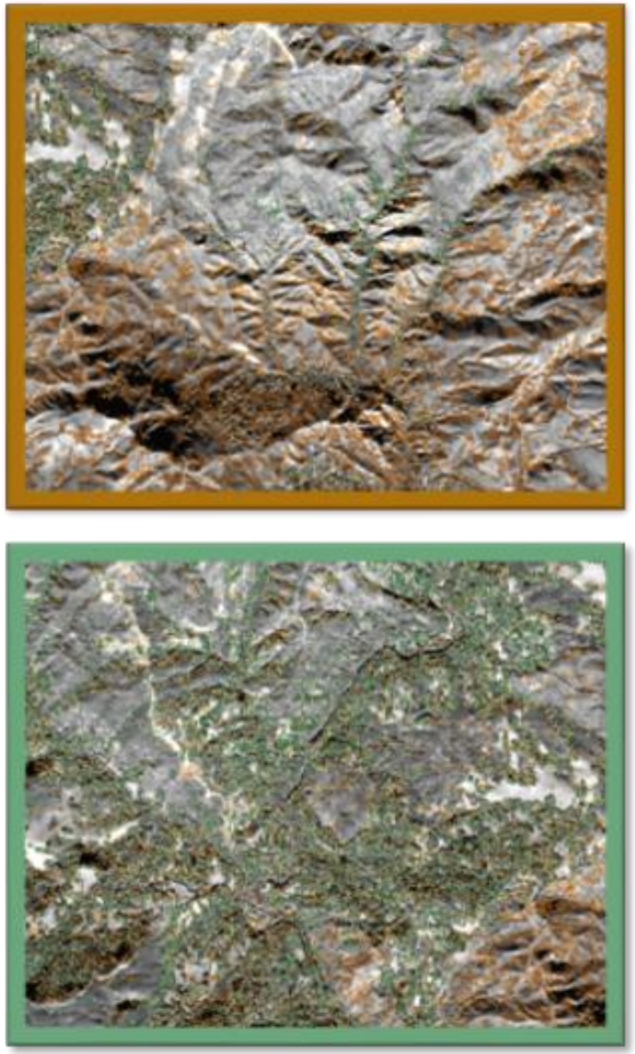




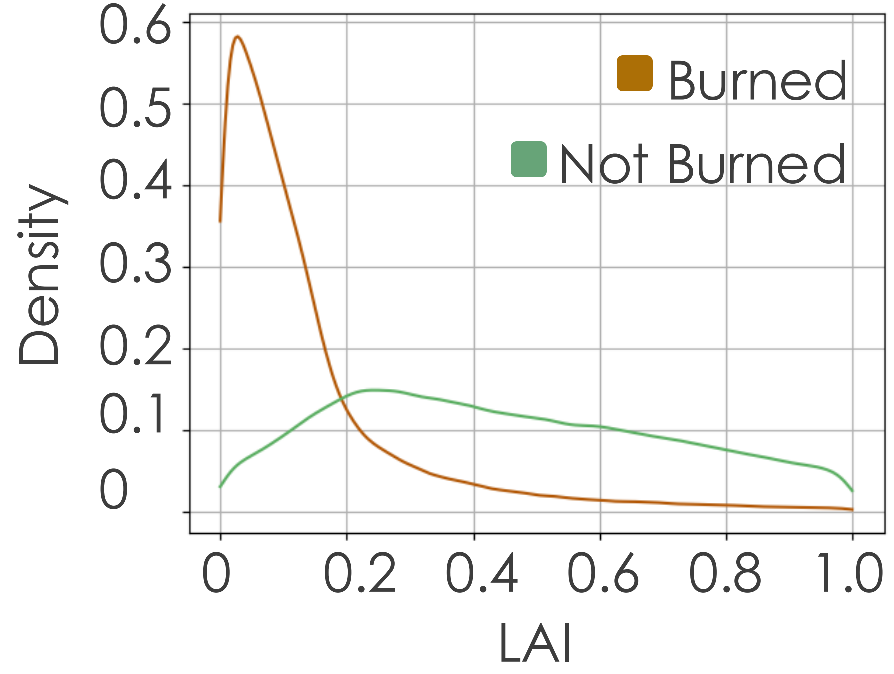


Data Source & Basemap Imagery: AVIRIS-3

Leaf Area Index Validation – Palisades Fire

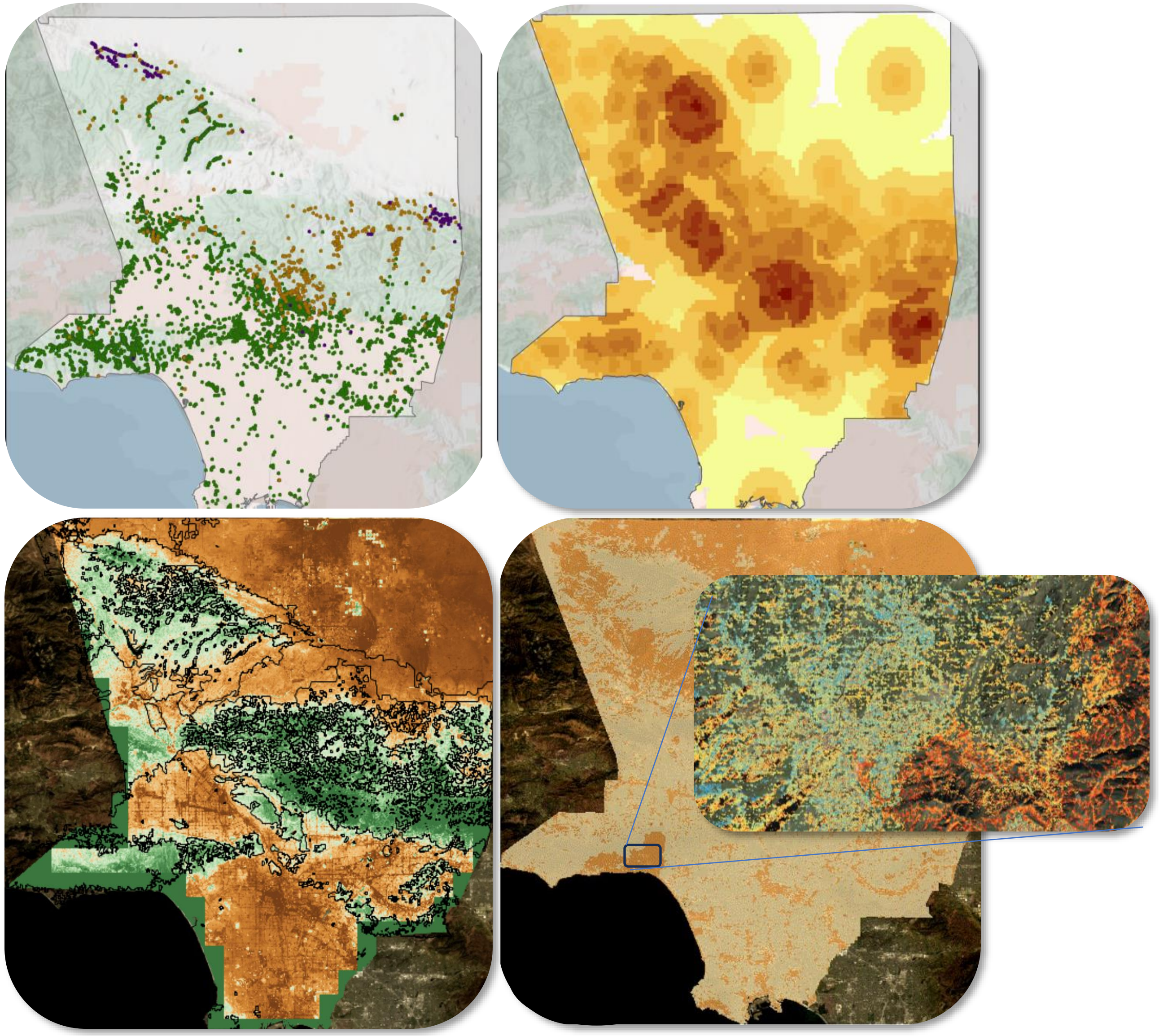


Data Source & Basemap Imagery: AVIRIS-3



Density Function for LAI of Trees in Santa Monica

Results Overview

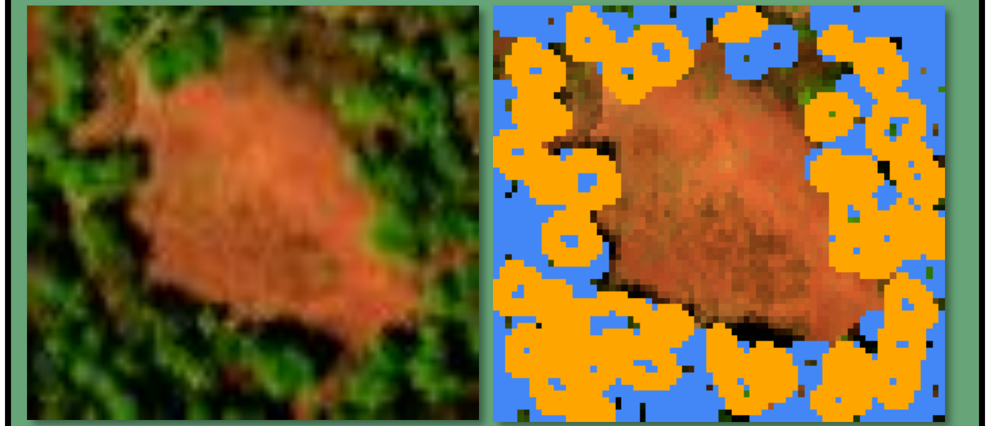


Takeaways

- Used a combination of **field survey data, environmental factors,** and **NASA Earth observations**
- **Identified stressed oak woodland regions** using the **Potential Risk Maps** and **Combined Health Metric**
- **Explored assigning tree-level health ratings** using high resolution data

Errors & Uncertainties

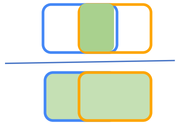
DeepForest Testing



AVIRIS RGB Composite

🟦 Observed
🟧 Predicted

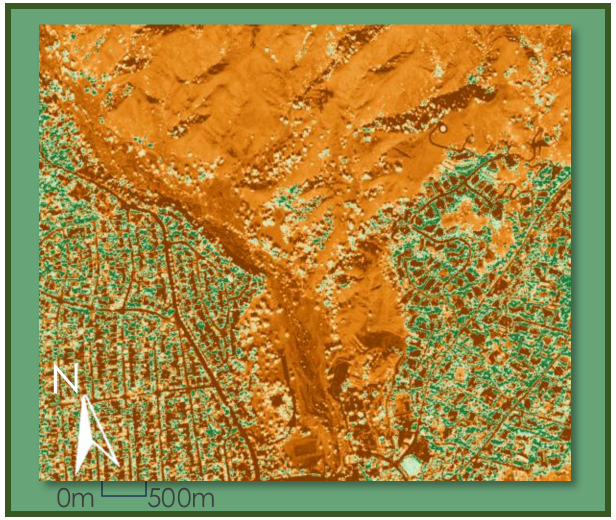
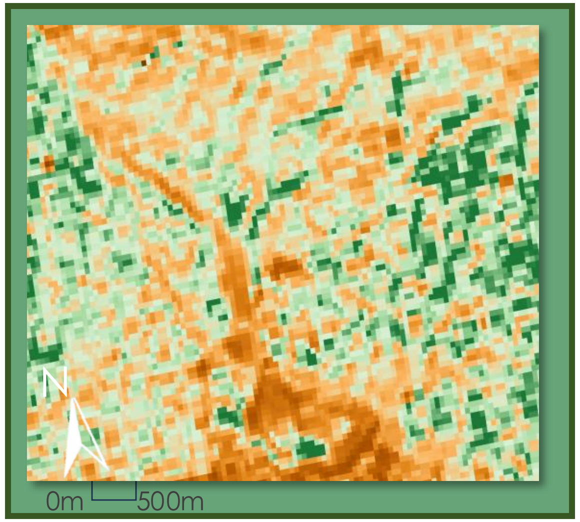
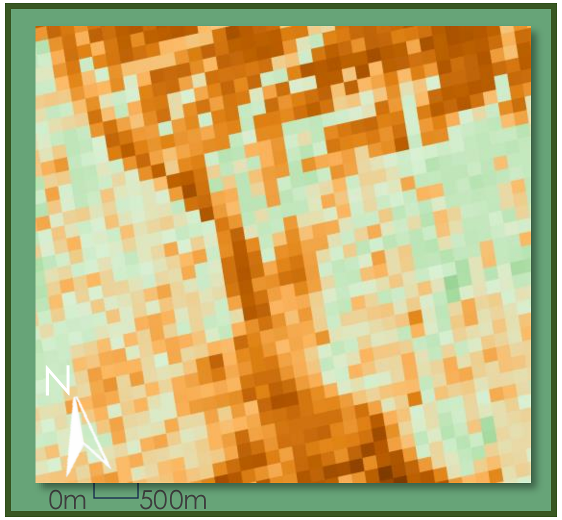
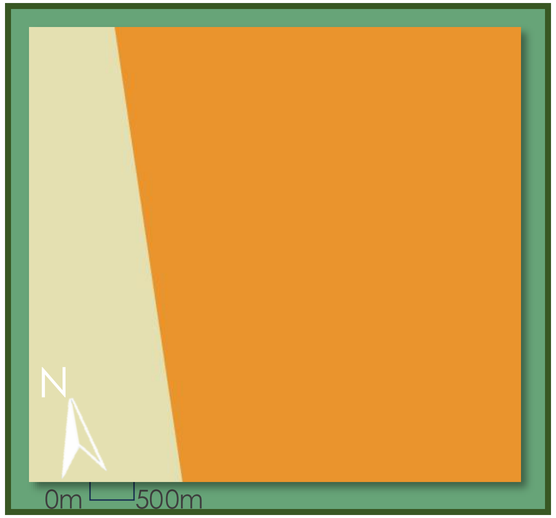
$$\frac{\text{Intersection}}{\text{Union}} =$$



Intersection-over-Union (IOU) Scores

Subregion	Mean Score
Topanga Canyon, SAMO	0.33
Southwest Santa Clarita	0.41
Eaton Canyon Watershed	0.31
All Tests	0.34

Partner Implementation & Feasibility

Subregion	County		
AVIRIS-3 1m-20m, Intermittent	HLS 30m, 2-3 days	ECOSTRESS 70m, Intermittent	OCO-2 1.3km, 8 days
LAI	NDVI	ET	SIF
			

Data Sources: AVIRIS-3, HLS, ECOSTRESS, OCO-2

Conclusions

- **Species level classification** was **not feasible** due to oak hybridization and a lack of uniform ground level data
- **County level health assessments** using a generalized model is **possible with refinement**
- **Combination of** lower and higher **resolution** data **validated with field survey data**

Image Credit: Caroline Baumann

Acknowledgements

Science Advisors

Latha Baskaran (NASA JPL, California Institute of Technology)

Zoe Pierrat (NASA JPL, California Institute of Technology)

Nick Parazoo (NASA JPL, California Institute of Technology)

Ben Holt (NASA JPL, California Institute of Technology)

NASA DEVELOP Program

Caroline Baumann (Center Lead, California – JPL)

Isabel Tate (Fellow, Alabama – Marshall)

Partners

Steve Steinberg (LA County Department of Internal Services)

Ron Durbin (LA County Fire Department)

Angie Saldivar (LA County Fire Department)

Special Thanks

Wen Wang (LA County Fire Department)

Sara Chin (LA County Fire Department)

Michael Pazmino (The Huntington Library)

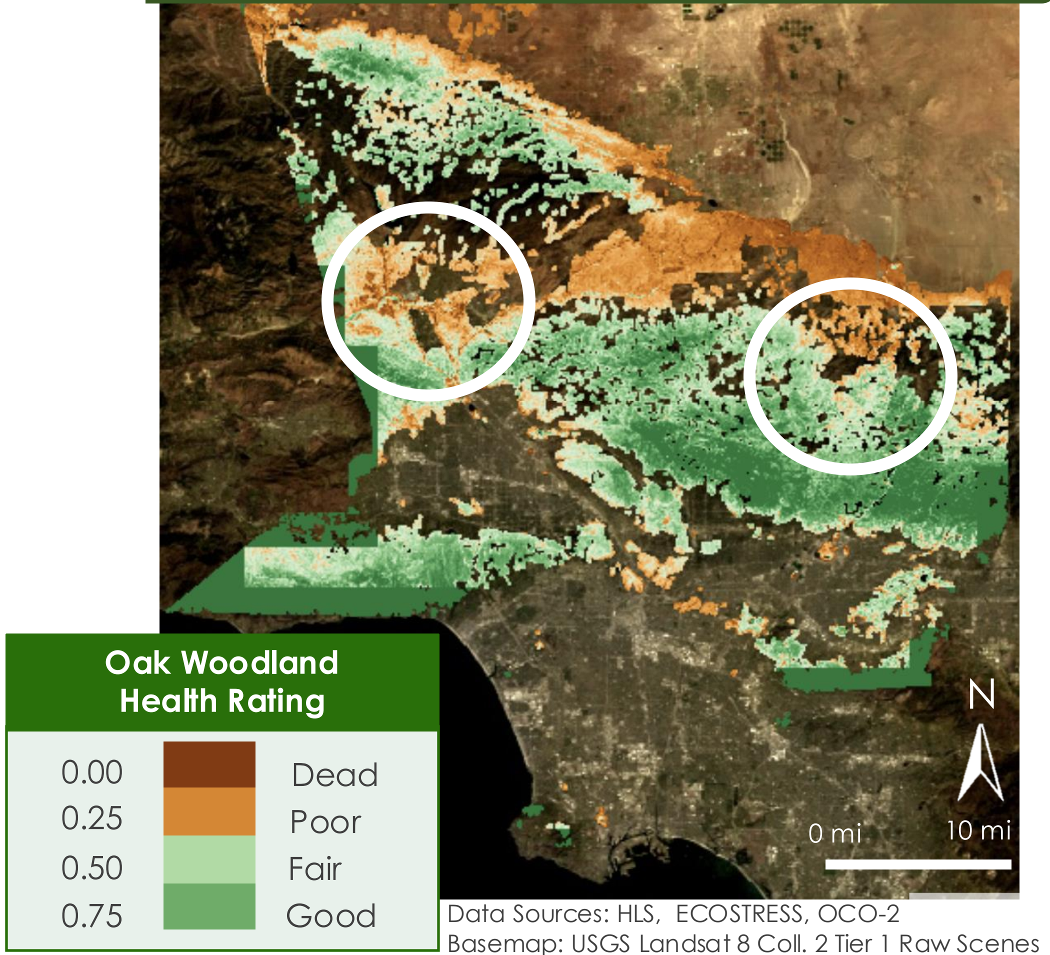
Thank you!

Image Credit: Caroline Baumann

Appendix: Combined Health Metric Assessment

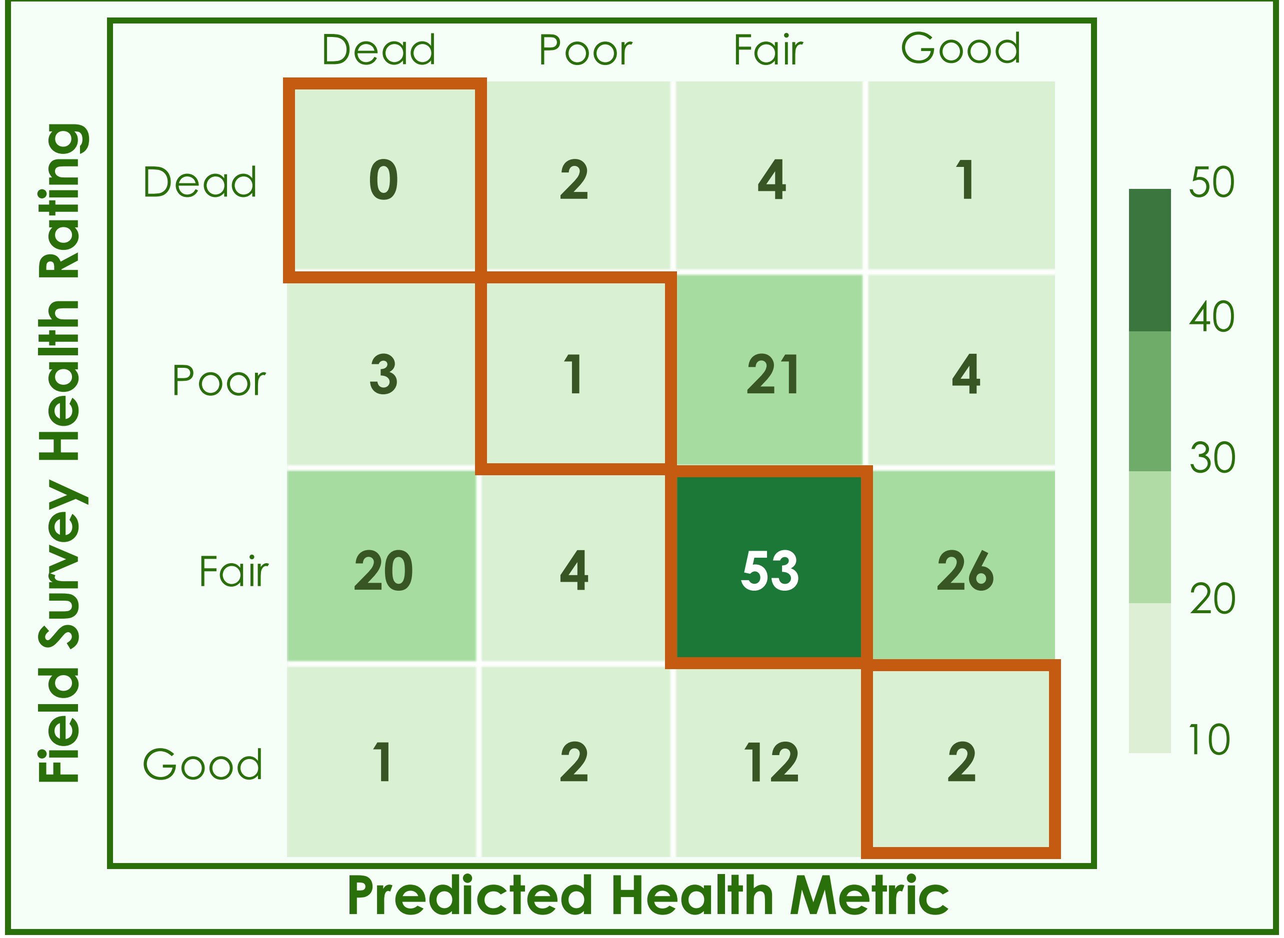
$$\text{Health Metric} = \beta0 + \beta1(\text{NDMI}) + \beta2(\text{NDVI}) + \beta3(\text{EVI}) + \beta4(\text{ESI}) + \beta5(\text{ET}) + \beta6(\text{SIF})$$

2024 Health Predictions



Data Sources: HLS, ECOSTRESS, OCO-2
Basemap: USGS Landsat 8 Coll. 2 Tier 1 Raw Scenes

Predicted vs. Actual Health Matrix



Field Survey Health Rating / Predicted Health Metric

	Dead	Poor	Fair	Good
Dead	0	2	4	1
Poor	3	1	21	4
Fair	20	4	53	26
Good	1	2	12	2